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ABSTRACT

The main objective of the Ohio State undergraduate program in Science and Mathematics, 1968-71, was to combine educational theory with classroom practice and to give preservice teachers experience in instructional and community settings at different grade levels. The program was divided into junior and senior levels. Emphasis during the junior year of the program was upon working with the individual pupil: first, as a tutoring one-to-one tutorial setting; then as a teacher in small-group activities; and finally, as an instructor of a class. The focus of the 2-quarter senior program was the socioeconomic setting and the effect of socioeconomic factors on the school: first, in a half-day teaching assignment divided in time between two schools in contrasting contexts (inner city, suburban); then, in a full-day teaching assignment in single school, usually one of those from the preceding quarter's experience. Observations and audio and video tapes were employed throughout the program to aid the preservice teachers in evaluating their professional growth in classroom performance. Evaluation indicated that teachers prepared by the program were significantly better than conventionally prepared teachers. (Author/JA)

ED 075432

AN INNOVATIVE PROGRAM FOR PREPARING SECONDARY SCHOOL TEACHERS IN SCIENCE AND MATHEMATICS EDUCATION

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THE OHIO STATE UNDERGRADUATE PROGRAM IN SCIENCE AND MATHEMATICS EDUCATION

The Ohio State University undergraduate program in Science and Mathematics Education is a cooperative preservice education program involving the Faculties of Science and Mathematics Education and Curriculum and Foundations within The College of Education. The Department of Educational Psychology and personnel of the Columbus Public Schools and other Franklin County, Ohio schools. Students are actively involved in teaching at elementary, junior high, and senior high school levels during four or five quarter sequences. Science and Mathematics Education faculty members maintain close contact with the students throughout the program by supervision of activities in the schools, individual conferences, small group seminars, and laboratory practicums. Emphasis during the junior year of the program is upon the individual pupil: first, in a one-to-one tutorial setting; then as a teacher in small group activities; finally, as an instructor of a class. The focus of the two quarter senior program is the socio-economic setting and the effects of socio-economic factors on the school: first, in a half-day teaching assignment divided in time between two schools in contrasting contexts (inner-city, suburban); then, in a full-day teaching assignment in a single school, usually one of those from the preceding quarter's experience. Observations, audio- and video-tapes are employed throughout the program to aid the preservice teachers in evaluating their professional growth in

classroom performance.

The program was first initiated in 1968-69 as a pilot program involving twenty-nine students. During the 1969-70 and 1970-71 school years the program was modified, based on evaluations by students, instructors, and observers as well as upon data obtained from several formal research studies. Student enrollment increased to 190 in 1970-71.

Evaluations conducted during 1969-70 and 1970-71 included both preservice and inservice teachers who have been involved in the program. Data from these investigations will provide further information to improve the program during the 1971-72 school year. Over 300 preservice teachers will be in the program during 1971-72 when it becomes the teacher education program for all science and mathematics education students at The Ohio State University.

INTRODUCTION

During the winter of 1967 the Faculty of Science and Mathematics Education reviewed its program for preparing secondary school science and mathematics teachers. As a result of this review, the staff decided the undergraduate program should be revised to accomplish a number of objectives. The program revision was a cooperative effort that involved public school personnel, prospective teachers, faculty from science and mathematics education, and faculty from other fields including educational psychology, sociology, educational philosophy, and curriculum and instruction. The program was developed at first on a pilot basis and then extended to larger numbers of students as the components of the program were evaluated and judged successful.

Information about the program is provided in the following sections: Program Objectives, Description of the Current Program (1971-72), and A Brief Case Study.

The section on program objectives briefly specifies the general objectives of the program. These objectives have guided the development of the program and are common to both science and mathematics education.

The second section describes the current programs which have evolved through development and evaluation.

The third section provides a brief case history detailing the major aspects of the developmental and evaluation efforts. Current and future developments are also detailed.

PROGRAM OBJECTIVES

The teacher education program of the Faculty of Science and Mathematics Education was designed to prepare teachers who are sensitive to individual differences, understand how children learn, understand how various school and community environments influence student behavior, and can organize and conduct effective learning experiences for varied groups of students in varied settings.

Specifically the program is designed to enable the pre-professional to:

1. Study teaching as a problem solving and decision making process;
2. Examine the responsibilities of the teacher in society, especially as they relate to cultural separation;
3. Acquire a capability to detect, and a sensitivity to, the boundary conditions governing a teacher's decisions;
4. Acquire sensitivity to societal and environmental differences which influence the teaching-learning process;
5. Ascertain the types and significance of evidence used in the problem solving and decision making processes;
6. Develop an ability to design alternative subject matter organizations and teaching strategies in contrasting school environments;
7. Demonstrate skill in the implementation of his decisions in contrasting school environments;
8. Acquire the capability to evaluate the results of implemented decisions, both his own and those of others.

DESCRIPTION OF THE CURRENT PROGRAM (1971-72)

The preservice program in science and mathematics education at The Ohio State University represents an attempt to combine educational theory with classroom practice and to enable preservice teachers to acquire experience in working with pupils in instructional and community settings at different grade levels(elementary, junior high, and senior high). The present programs consist of a five quarter sequence in science education and a four quarter sequence in mathematics education. Nearly all students are placed in schools within 20 miles of the university.

Junior Program

A general description of the first quarter of the junior year program (J1) is outlined below.

1. Focus: Individual junior high school students
2. Objectives: The J1 student will
    a. Be able to identify the interests, needs, and background of an individual student.
    b. Identify some learning styles of junior high school students.
    c. Be able to identify and locate resources which can be used in attempting to help students learn.
    d. Become able to communicate effectively with a student in a one-to-one relationship.
    e. Develop and use a variety of tutorial teaching strategies.
    f. Gain poise and confidence in his ability to function as a tutor.
    g. Develop means of evaluating his own progress as a tutor as well as his student's progress in learning mathematics or science.

h. Become an intelligent observer of classroom interaction and the resultant influence on individual student interest and achievement.

i. Gain insight into the many and varying roles of a teacher.

j. Become acquainted with the philosophy and objectives of a particular junior high school and the school's instructional procedures, administration, counseling, and mathematics or science department personnel.

k. Become aware of personal strengths and weaknesses as a potential teacher, particularly in a junior high school setting.

3. Program:

Each college junior works as a tutor in a junior high school with a pupil who has been identified by a classroom teacher as one who needs help in mathematics or science. The J1 student tutors his pupil twicea week, one period each time. Video tapes are made of some tutoring sessions and are analyzed in follow-up seminar sessions. The J1 student spends additional time in the school observing mathematics or science and other classes, and in becoming acquainted generally with the school's program and staff; a college staff person is present to serve as a resource person in these efforts.

Two seminars are held each week. At least one of the seminars is held at the junior high school with classroom teachers, faculty from mathematics or science education, and faculty from curriculum and foundations. Seminar discussions center around problems

encountered by the J1 students in their tutoring situations or in other situations they have observed in the school. These problems might include methods of identifying learning problems, alternative means of motivation, instructional strategies, teaching styles, methods for stimulating interest in mathematics or science, and the development of methods to evaluate the success of tutoring sessions.

4. Activities:

To accomplish the objectives listed above, the J1 student engages in school based activities such as the following:

a. Meets twice weekly with the pupil he is tutoring.

b. Studies his pupil by observing him in other school situations and by gathering information from other sources such as teachers, counselors, nurse, and cumulative records.

c. Observes more than once at least four teachers in the school. At least two of these teachers should be in fields other than science or mathematics; attempts to determine in each case (1) the teacher's approach to content, (2) the teacher's pattern of interaction with his pupils, and (3) the teacher's techniques of classroom management.

d. Discusses in an exploratory fashion with some teachers their ideas about teaching.

e. Studies the pattern of testing, grading, and evaluating pupil progress used in the school.

f. Analyzes the teaching strategies he uses and assesses the quality of communication and rapport he is able to esta lish

with his pupil .

A general description of the second quarter of the junior year program (J2) is outlined below.

1. Foci: Individual (elementary school) pupils as members of small groups; child growth and development; and learning theories.

2. Objectives: The J2 student will

   a. Become able to identify individual pupil and teacher differences which influence the learning patterns of elementary school pupils.

   b. Develop and use instructional strategies which honor individual differences in small groups.

   c. Become familiar with group dynamics research and start to use this information to improve teaching and learning in small and large group settings.

   d. Become aware of the elements involved in the concept of "motivation" and the importance of motivation as a factor in pupil success in school.

   e. Acquire knowledge of child growth and development and apply this knowledge in learning activities to be used with pupils.

   f. Acquire knowledge of what is involved in concept formation and problem solving and apply this in learning activities.

   g. Acquire understanding of what is involved in creativity and divergent thinking and use this in learning activities.

   h. Identify curriculum problems and programs and materials designed to provide solutions to these problems (elementary school mathematics and science).

i. Become acquainted with the objectives and philosophy of the school's elementary mathematics or science program and its relation to the corresponding secondary school program.

j. Become familiar with the philosophy and functioning of a particular elementary school, its staff, and the population it serves.

k. Learn to function as a member of a teaching team as he works with other adults and a class of elementary school pupils.

m. Become increasingly aware of his personal strengths and weaknesses as a potential teacher, particularly with elementary and junior high school pupils.

3. Program:

As many as four J2 students may be assigned to a single cooperating teacher in an elementary school, but each student is primarily responsible for only one small group of pupils. J2 students spend four to six hours per week in the school with about half of that time devoted to instruction of their small groups and working with their cooperating teachers. The remaining time is used in observing class activities in the building, and in conferring with their cooperating teachers and with other school personnel.

Two seminars are held each week. At least one of these is held at the elementary school so that interested and available cooperating teachers as well as J2 students and university personnel can provide discussion input. Seminar topics again center around problems encountered by J2 students and might include establishing favorable

learning climates, teaching techniques useful for small groups, principles of group dynamics, methods of analyzing student interaction, ways of utilizing individual differences in teaching science and mathematics and other matters related to understanding and using a sound psychology of learning.

J2 students in science education are also involved in additional activities on campus. They continue work with the individualized laboratory modules which emphasize the process and product concepts inherent in the nature of science. They are also expected to develop instructional packages which illustrate the nature of science and which can be used in their teaching. Techniques of evaluation and methods for effective planning are also emphasized.

4. Activities:

To accomplish the objectives listed above, the J2 student engages in school based activities such as the following:

a. Works twice weekly with the small group of elementary children to whom he is teaching mathematics or science.

b. Studies very carefully at least two pupils in his instructional group in terms of their learning styles, motivation, and other psychological-sociological factors.

c. Observes more than once at least three teachers in the school attempting to determine in each case (1) the teacher's approach to content, (2) the teacher's pattern of interaction with his pupils, and (3) the teacher's techniques of classroom management.

d. Discusses in an exploratory fashion with some teachers their ideas about classroom management, teaching the non-reader, creativity in young children, and other topics.

e. Uses a variety of methods and techniques in presenting mathematics or science content. Gives special attention to inquiry teaching and using questions to promote higher level thinking.

f. Devises and uses methods of evaluating student progress without resorting to paper and pencil tests.

g. Studies the feasibility of integrating mathematics and/or science with other subjects.

h. Observes the general socio-economic nature of the families living in the school attendance area.

i. Analyzes the similarities and differences in the "teaching styles" of elementary and junior high school teachers.

j. Studies the pattern of testing, grading, evaluating, and reporting of pupil progress used in the school.

k. (Science only) Completes, on campus, a series of individualized laboratory activies which emphasize the process nature of science and the development of behavioral objectives for science instruction.

A general description of the third quarter of the junior year program (J3) is outlined below. Only science majors are involved.

1. Focus: Individual senior high school students in laboratory and classroom settings.

2. Objectives: The J3 student will

a. Apply knowledge of teaching-learning theory and adolescent psychology to solve problems encountered in the classroom.

b. Demonstrate effective inquiry strategies for laboratory activities in high school science classes.

c. Use behavioral objectives, involving the three domains, in preparing lesson plans for classroom or laboratory instruction.

d. Use effectively audio-visual materials appropriate for teaching specific topics or concepts.

e. Demonstrate a knowledge of appropriate evaluation techniques for assessing outcomes of instruction; including student self-evaluation.

f. Identify different patterns of pupil and pupil-teacher interaction as they occur in small and large groups.

g. Identify characteristics of a favorable learning environment.

h. Exhibit poise and confidence when placed in charge of various teaching situations.

i. Become familiar with the philosophy and objectives of a particular senior high school.

j. Use self-evaluation techniques regarding his personal strengths and weaknesses as a potential teacher.

3. Program:

J3 students are assigned in pairs to a senior high school science class with the expectation that they will have regular opportunities to conduct laboratory activities. While the student may work with

his cooperating teacher as a laboratory assistant, he is also responsible for teaching laboratory activities to the total class.

Seminars are held once a week with J3 students, school personnel, and university staff members participating. Seminar problems focus on total classroom activities, methods and strategies for inquiry teaching in a laboratory setting, evaluation techniques, problems of adolescents, dynamics of group interaction, and the philosophy and operation of a specific senior high school.

4. Activities:

To accomplish the objectives listed above, the J3 student engages in school based activities such as the following:

a. Works twice weekly with an entire class in a laboratory activity.

b. Develops sound lesson plans for inquiry-oriented laboratory activities which he will teach.

c. Continues, on campus, with activities which deal with laboratory and field skills and techniques needed for teaching in their areas of specialization. Also included are activities designed to develop skill in using office machines, AV materials, and in developing evaluation instruments.

d. Prepares work sheets, study guides, quizzes, transparencies or other instructional materials useful in teaching the scheduled laboratory activities.

e. Develops and uses methods of evaluating student progress without resorting to paper and pencil tests.

f. Evaluates the laboratory facilities, equipment, and materials available in the school.

g. With the aid of the school librarian reviews the supplemental or enriching materials available. Determines how these are and may be used by teachers and students.

h. Ascertains the attitudes of various students toward the school's program.

i. Observes at least six teachers in operation in their classrooms. Tries to determine (1) their approach to content, (2) their interaction with students, (3) their techniques of classroom management, and (4) their general level of satisfaction with being high school teachers.

j. Observes the general socio-economic status of the families living in the school attendance area.

Senior Program

A general description of the first quarter of the senior year program (S1) is outline below.

1. Foci: The influence of contrasting communities and differing grade levels on teaching-learning in secondary schools; A problem solving stance toward pedagogical problems in mathematics and science education; The nature of mathematics and science to be considered in developing student activities.

2. Objectives: The S1 student will

a. Develop an understanding of the underlying cultural elements characterizing urban, suburban, and rural areas and their impact on the schools.

b. Develop sensitivity to the differences in cultural backgrounds of students and the effect of these differences on learning.

c. Re-examine similarities and differences between junior and senior high school students and the educational programs offered to each.

d. Acquire understanding of the origin and nature of the charge made by some critics that the public school system is racist and irrelevant and does not meet the needs of groups such as inner-city blacks.

e. Acquire a sense of the political workings and functioning of a department, school, and school system.

f. Become more aware of the nature of good teaching and the characteristics of "good teachers" as perceived by high school students.

g. Acquire skill and insight into using the nature of mathematics and/or science as a guide and tool in planning student activities.

h. Develop insights and skills involved in long and short term planning for teaching.

i. Acquire insight regarding how students' cultural influences and learning capabilities should guide the selection of instructional objectives, activities, materials, and methods.

j. Become able to interpret test scores from teacher made and standardized tests, apply statistical techniques to test

construction and use this information to improve the teaching-learning situation.

k. Become able to analyze a video-tape or audio tape of his teaching to gain insight into verbal and non-verbal behavior. Demonstrate the ability to evaluate his teaching performance.

l. Explore the use of team teaching.

m. Gain a spirit of professionalism which includes striving for considered changes and improvements.

n. Continue to achieve, at a higher level, many of the objectives listed for previous quarters.

3. Program:

S1 students are assigned in pairs to work with cooperating teachers as teaching assistants for four weeks in an inner-city school and an equal time in an outer-city school. The S1 students assist teachers and engage in other activities in the schools four periods a day, five days per week.

The college seniors provide considerable help as junior members of "instructional teams." They prepare and conduct demonstrations, assist in laboratory work, prepare guidesheets or other instructional materials, assist in evaluating pupil progress and work with individuals and small groups in need of special help. In addition the senior gets an opportunity to teach an entire class several times during his four weeks of heavy involvement in the schools.

Seminars which focus on understanding school based experiences

in a framework of principles, practices, and philosophies of secondary education are held twice a week. In addition to the seminars there is classwork in philosophy and/or sociology of education. S1 students also continue to study special methods of teaching mathematics for science and develop instructional materials which they can use in the schools or in their future teaching.

Students are expected to become aware of many of the "realities of public schools" by observing widely throughout the school, by talking with many school personnel, by informal conversations with pupils, by attending after school or evening functions such as faculty or PTA meetings, and by studying the socio-economic factors in operation in the school's attendance area. Students also are introduced to the educational problems and practices found in other locations such as the Cleveland Public Schools and the Fairfield School for Boys (a state training school for boys).

Specialists from areas such as urban sociology, mental health, juvenile delinquency as well as educational personnel from the Columbus public schools are involved as resource personnel for on-campus discussions about educational problems.

Each S1 student keeps a "log" which is a personalized record of his experiences during the quarter with particular emphasis on analyzing, interpreting, and evaluating the experiences.

4. Activities:

   a. Accomplishes at a continuously higher level many of the activities specified for J1, J2, and J3 programs.

b. Works daily (half-days) for eight weeks in two contrasting secondary schools with cooperating teachers, assisting with the instructional and evaluation programs for these teachers' classes.

c. Observes widely throughout the schools to become more knowledgeable about the programs, practices, and problems in each. This entails attendance at school functions such as school assemblies, athletic events, school club groups and informal activities such as spending some time in the school's faculty lounge.

d. Confers with guidance personnel, instructional coordinator, visiting teachers, students, school administrative personnel, and others concerning the school's socio-economic nature and community attitudes toward school. This usually includes some "touring" of the schools' attendance area and visiting in some homes.

e. Reads widely on topics such as the education of disadvantaged learners, alienated youth, problems of urban education, philosophy and sociology of education. Participates in seminar discussions which will draw upon such literature to help clarify questions which grow out of participation in public school programs.

f. Writes a comprehensive log in which will be produced a personalized record of his experiences throughout the quarter. Emphasis is to be placed on analyzing, interpreting, and evaluating the experiences.

g. Reads widely in the specialized literature of science or mathematics education.

A general description of the second quarter of the senior year program (S2) is outlined below.

1. Foci: Successful student teaching experience which integrates previous professional learnings.

2. Objectives: The S2 student will

   a. Integrate and utilize the skills and understandings developed through involvement previously in the J1, J2, J3, and S1 programs.

   b. Test and evaluate instructional ideas through classroom application.

   c. Become familiar with and active on a full-time basis in the school-community setting.

   d. Identify community resources in his school's attendance area and in larger community which are available and useful in developing his instructional program.

   e. Use evaluation feedback in dealing with parental concerns relative to their child's growth and development.

3. Program:

The S2 student is usually assigned to full-time student teaching with a cooperating teacher he has worked with the previous quarter. In this situation he is usually able to take immediate responsibility for two classes and very quickly assume total responsibility for three classes. The remainder of his time in the school is used to broaden understanding and competency by (1) working with other teachers in his discipline in the school, (2) observing other teachers and students in a wide variety of situations, (3) helping with the extra-curricular activity program, (4) supervising study halls and lunchrooms, (5) helping with testing, grading, and record keeping responsibilities, and,

in general, doing almost everything that will be expected of him as a regular teacher. For a period of time, the senior assumes a full teaching and supervisory load as carried by regular teachers.

While providing a model of good teaching, it is hoped that the cooperating teacher, working with the student and with the college supervisor, will help the student develop his personalized style of teaching, which may be similar to or quite different from that of his cooperating teacher.

It is anticipated that the cooperating teacher and senior will plan a sizeable number of teaching situations in which they work together as an instructional team, thereby enriching instruction and, hopefully, learning from each other.

The cooperating teacher is expected to regard himself as a very important part of a teacher education team working with the college supervisor and others to prepare better science and mathematics teachers.

4. Activities:

   a. Engages in a full-time student teaching experience for one quarter initially taking responsibility for two classes and quickly a third one.

   b. Plans with the cooperating teacher a number of teaching situations in which they work together as an instructional team.

   c. With the aid of cooperating teacher and college supervisor, engages in careful self-examination of strengths and weaknesses as a teacher.

   d. Uses community resource personnel to obtain judgments concerning their satisfaction with the school's program and to enrich the instructional program if feasible.

e. Discusses with public school and college teachers issues, concerns, practices, and policies in secondary education for the purpose of clarifying his own position on these matters.

DEVELOPMENT AND EVALUATION

The Ohio State University program for preparing secondary school science and mathematics education teachers was reviewed in the fall and winter of 1967 to determine what changes should be made. With financial support from The Ohio State University and the College of Education, the decision to change the program could be implemented.

Working with school personnel from the Cleveland Public Schools and the Columbus Public Schools, college students, and Ohio State staff the program was designed and implemented on a pilot basis for 29 Ohio State seniors during 1968-69. The pilot senior program was evaluated and expanded in 1969-70. The junior program was begun on a pilot basis in 1969-70 and expanded in 1970-71 after evaluation. Both programs were modified after the 1970-71 year and became the program for the preparation of science and mathematics teachers at The Ohio State University. A follow-up program to bridge the interface between university preparation and inservice teaching is planned for pilot development during 1972-73.

Evaluation has been conducted during each of the years of the program. Seven Ph.D. dissertations have been completed assessing the Ohio State students completing the program. Summative and formative evaluation data have also been obtained.

Data obtained have included evaluations of the Ohio State students by peers, public school students, cooperating teachers, and university personnel. Data have been obtained regarding teaching style, student-teacher relationships, teacher attitudes (toward a variety of factors), teaching ability, influence of the teacher on the public school students, use of various instructional materials, and other variables. The analyses have been conducted to determine how the Ohio State teachers have changed during the program and how they change during the first year of contracted teaching.

Results indicate that the teachers prepared by this program are rated as significantly better than conventionally prepared teachers on a number of characteristics including the following:

(1) Positive influence on students

(2) Teaching in the styles desired by the personnel developing the program

(3) Increased involvement of students in activities

(4) Perception of instructional problems

(5) Use of effective solutions for instructional problems

(6) Tolerance for difficult situations

(7) Commitment to remain in teaching

(8) Interest in, and ability to work with students, and with students with varied home backgrounds and learning problems.

Dissertations are available to document all these generalizations.

In addition the evaluation of the program has identified a number of significant factors influencing the success of the program. The program is being modified in minor ways to determine whether these factors can be changed in such a way to improve the program. Among the factors are College Student Factors (Can we change these?, or Should they be selection criteria?); Cooperating Teacher Factors (Can we change those attitudes which are related to negative program outcomes through inservice work?, or Should we avoid these teachers?); College Supervisor Factors (Can we provide sufficient or different assistance to improve the outcomes in areas where we have not made desired gains?); Learning Rate Factors (Most attitude changes will require 4 to 5 quarters of involvement--Some attitudes need to be considered earlier in the program). Facility and Instructional Material Factors (Can we work with schools more effectively to obtain facility and instructional material changes which will provide better educational settings for the public school student and at the same time better settings for the Ohio State University preservice teacher?)

We feel the program has made a significant improvement in the preparation of teachers at The Ohio State University. The cooperative activity between the University, the public schools, and the community has aided all three. It is evident at this time that the public schools desire to continue the program and to increase their involvement in it; community agencies with whom we have worked also desire to increase their involvement in the program.

We believe the program also offers a model for teacher education that other institutions could use. Parts of the model are being tried by several institutions as a result of hearing and seeing presentations and a 35mm slide program we have given at both national and regional science and mathematics education meetings. Dissemination of the program has also resulted from graduate students who have worked in the program developing similar plans for programs in colleges where they have gone to teach.

Finally, the research and evaluation program has provided longitudinal research on prospective teachers and on factors which influence the success of teachers of science and mathematics, as well as research on factors influencing public school science and mathematics programs. Much information has already been obtained which has been useful in program modification; other data with further replication may also

yield educationally significant information. The number of Ohio State University students in the program each year (about 180 juniors, 170 seniors) the number of public schools involved, and the number of teachers involved, have presented and will continue to present excellent opportunities for research and evaluation.

Future efforts of the program will include increased inservice work with teachers in cooperating schools, encouraging and assisting local curriculum development efforts in cooperating schools, providing more community involvement for the Ohio State University preservice teachers, providing follow-up assistance to teachers who teach in Ohio during their first year of teaching, and maintaining the research and evaluation program.